

The 2007 New York On-Farm Soybean Rust / Soybean Aphid Monitoring Network

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Objectives

- 1) Establish soybean sentinel sites to enable timely collection of soybean crop growth and development and specific pest data from representative areas of NY soybean production.
- 2) Share results of sentinel plot surveys with NY producers and national soybean rust and soybean aphid websites: USDA SBA/SBR PIPE (www.sbrusa.net) and [Stop Soybean Rust www.stopsoybeanrust.com](http://www.stopsoybeanrust.com).

Background and Justification:

Soybean acreage has increased nearly 6 fold in NY since 1989 with an estimated 205,000 acres planted in 2007 (1989-2007 NYS Ag Stats). Soybeans fit well with typical cash grain and dairy production systems, providing a useful crop rotation option, an excellent on-farm addition to dairy and livestock rations, and provide a valuable cash crop. The trend in NY soybean acreage expansion is expected to continue as commodity price remains high, as producers incorporate soybean feedstuffs into dairy rations and local markets are enhanced by availability of commercial roasters and oil processing plants.

Soybean pest concerns have historically been minimal in the Northeast, generally restricted to weed competition, with relatively few insect, disease and vertebrate pests affecting crop yields. Two new pest species, the Asian soybean aphid and Asian soybean rust, have however recently been introduced into the US and threaten soybean production. Soybean aphid populations were first detected in the US in 2000 and observed in NY in 2001. Soybean rust was confirmed in the southeastern US in November 2004. Fortunately this disease has not, to date, been found in NY.

Prior to the first occurrence of soybean rust (SBR) in the US, SBR information was provided to stakeholders through diverse, but disconnected, outlets. Once the disease was detected a more coordinated information system was needed prompting the USDA-APHIS to establish a coordinated national system of soybean sentinel plots that would assist in the early detection of soybean rust and distribution of SBR information resources across the soybean production regions of the US. This program was named the Soybean Rust Pest Information Platform for Extension and Education (SBR PIPE). The national sentinel plot effort was funded in 2006 by the US Department of Agriculture (USDA), the United Soybean Board (USB), and the North Central Soybean Research Program (NCSRP). A total of 35 states and five Canadian provinces

had sentinel plots for monitoring soybean rust (SBR) and soybean aphid (SBA). A single SBR and SBA monitoring protocol was developed for the USB/NCSRP, USDA, and Canadian plots. Data from all sentinel plots was uploaded to the USDA - Legume Pest Information Platform for Extension and Education (PIPE) website. In 2007 the national sentinel plot effort was again funded with soybean rust (SBR) and soybean aphid (SBA) sentinel monitoring plots located in 41 states, Puerto Rico and 5 Canadian provinces. More information on the USDA PIPE network is available at: www.sbrusa.net.

The national sentinel program serves three important functions. The primary function is to serve as a warning network to track the spread of the soybean rust in North American soybean production regions. For this reason and because the pathogen can only over-winter in subtropical regions, southern and Mississippi Valley states have higher numbers of sentinel plots relative to their soybean acreages than states in other regions. The second function is to quantify the timing and amount of spore production in over-wintering and growing season source areas, an important input for the soybean rust aerobiology prediction system. A third function of the sentinel plot system is to collect data for epidemiological research.

The New York State (NYS) Sentinel Plot Network has been active since 2005. In 2006 and 2007, the number of sentinel plots scouted doubled from 10 in 2005 to 20 in 2007, due to the dedicated effort of volunteers from industry, university and extension. Plots were monitored from June through September in 2006 and 2007. All samples submitted from sentinel plots during this time period were not only examined for soybean rust but also for several foliar diseases including septoria brown spot, downy mildew, bacterial pustule, bacterial blight and frogeye leafspot. In 2006 and 2007 monitoring efforts were expanded to include an assessment of soybean aphid populations.

In addition to providing the New York soybean industry with an early detection and communication system for Asian soybean rust (SBR) and soybean aphid (SBA), the sentinel plot network also serves as a focal point for assessment and communication of broader pest management issues affecting soybean production.

Procedures:

CCE personnel were provided an overview of the program objectives and invited to participate in the 2007 sentinel monitoring network. Interested CCE staff contacted commercial field crop producers to identify local soybean fields for enrollment as sentinel plots. Efforts were made to increase statewide coverage by including sentinel plots on Long Island and in counties along the Northern NY border and the Pennsylvania border. The 2007 NYS sentinel plot network consisted of 20 sentinel plots (50 x 50 ft areas within commercial soybean fields) in 19 counties. Scouting was conducted by volunteers from Cornell Cooperative Extension (CCE), industry and USDA-NRCS. Protocols for establishing, monitoring and sampling sentinel plots were provided by USDA. A synopsis of SBR and SBA sampling protocols follows. A more complete discussion of New York State 2007 soybean rust and soybean aphid scouting protocols are shown in Appendices 1 and 2. Sentinel plot monitoring began in mid June and continued through early September.

NY Soybean Sentinel Plot Sampling Protocols:

Soybean Rust Detection (a synopsis of SBR sample collection protocol)

- a. During the early vegetative stages of growth, plots were monitored weekly, with notes made on visible problems, only leaves that have visible disease are collected and submitted to the Cornell Plant Disease Diagnostic Clinic.
- b. Once plants reach the V5 (fifth leaf stage) stage, scout plots weekly for the presence of SBR by arbitrarily collecting or observing a minimum of 100 leaflets from the lower canopy (oldest, main-stem terminal leaflets) at each site. Collect representative leaves from plants outside of the marked sampling areas showing suspicious symptoms in a separate bag for laboratory inspection.
- c. Place samples in the bag with the collection label that corresponds with your plot.
- d. Complete the label with your name, the collection date and the plant growth stage.
- e. Place the labeled bag inside another Ziploc bag.
- f. Fedex sample overnight to the Cornell University Plant Disease Diagnostic Clinic.
- g. Cornell University Plant Disease Diagnostic Clinic personnel will process samples for disease assessment

Soybean Aphid Assessment (a synopsis of SBA (sampling protocol)

- a. (pre-reproductive) to early reproductive (i.e. flowering) growth stages. Current research data suggests that treatment during vegetative soybean growth stage is not likely to result in an economic return.
- b. When scouting for SBA, select 20 plants at random, each from a different location (not consecutive down the row) so that the 20 plant-sample is representative of the entire variety/cultivar. Identify the average plant growth stage.
- c. Examine the entire plant beginning with the growing point (newest trifoliolate) for soybean aphids.
- d. Count aphids when there are 250 or fewer per plant. Estimate numbers when populations are above 250 per plant. Categorize estimates as follows: 250-499; or 500 or above.
- e. (FYI: within-field aphid numbers will be mapped on the PIPE site in the following categories: a) 0; b) 1-5; c) 1-39; d) 40-149; e) 150-249; f) 250-499; and g) 500 and above.
- f. Indicate the number of plants examined when the number is other than 20.
- g. In cases where the average was not an estimate but a count, indicate that on the data entry sheet. Incidence (number of plants with aphids) may also be indicated on the data entry sheet.

CCE collaborators shared New York SBR/SBA sentinel site scouting reports weekly with the project leaders. These data were uploaded by Mary McKellar (NEPDN and Cornell Plant Disease Diagnostic Clinic) to the national PIPE website (www.sbrusa.net) in a timely manner consistent with scouting frequency. McKellar and Bergstrom (SBR) and Waldron (SBA) compiled and summarized SBR and SBA information from NY state reports. Mary McKellar uploaded their summaries to the SBRUSA.net website. In addition, summaries were shared with New York clientele via updates to the New York Soybean Rust Information Center (www.ppath.cornell.edu/soybeanrustny/).

A season recap conference call with all of the scouts was held in September of 2007. This meeting allowed for discussion of the functionality of the network, disease trends in soybean in NYS as well as plans for the next growing season.

Results and Discussion:

Thanks to the efforts of Cornell Cooperative extension, USDA personnel and cooperating soybean producers twenty soybean rust / soybean aphid sentinel sites were established in 19 New York counties in 2007, figure 1. Two sentinel plots were located in Seneca county, with 1 plot

each in Cayuga, Chautauqua, Chemung, Chenango, Columbia, Cortland, Jefferson, Monroe, Oneida, Onondaga, Ontario, Oswego, Otsego, St. Lawrence, Steuben, Suffolk, Wayne, Wyoming counties. Regular field monitoring began in mid June and continued through early September.

Disease monitoring:

The majority of foliar disease samples were collected from July through August. Over 25,000 leaflets were incubated and examined from sentinel plots during this time period. All foliar samples were processed by the Cornell Plant Disease Diagnostic Clinic which also serves as the Northeast Plant Diagnostic Network's Regional Hub Laboratory.

NYS sentinel plot samples were assessed for soybean rust and other soybean foliar diseases including septoria brown spot, downy mildew, bacterial pustule, bacterial blight and frogeye leafspot. Diagnosis of foliar diseases was made by visual examination of symptoms after 24-48 hours of incubation in a moist chamber. Soybean rust was not detected in NY this season. Weekly scouting efforts did, however, document occurrence of other soybean diseases including Septoria brown spot, downy mildew, bacterial pustule and frogeye leafspot. Overall, occurrence of soybean foliar diseases in NYS was lower in 2007 than 2006 with the exception of Septoria brown spot (figure 2).

Bacterial blight, sudden death syndrome and brown stem rot, the latter two first detected in the 2006 NY SBR/SBA surveys, were not detected in 2007. Bacterial blight and brown stem rot are favored by cool, wet weather. Sudden death syndrome is favored by wet conditions during flowering. The drier, warmer weather in July/August 2007 may have contributed to the absence of this disease in NYS sentinel plots. Despite the greater statewide occurrence of Septoria brown spot in 2007, the incidence of this disease within individual sentinel plots was lower in 2007 as compared to 2006 (data not shown). Prior to 2006, frogeye leafspot had not been reported on soybean in NYS. Its discovery may be more of an artifact of the intense scouting for soybean rust in NYS sentinel plots rather than due to a new introduction in NYS in 2006. Regardless of when this disease arrived in NYS, it only occurred in 4 out of 19 sentinel plots in 2006 and 2 out of 20 sentinel plots in 2007. Whether or not this disease will become prevalent in NYS soybean fields remains to be seen.

A general decrease in precipitation levels across most areas of NYS in 2007 as compared to 2006 (table 1) may have contributed to the lower occurrence of soybean foliar diseases in NYS sentinel plots in 2007.

Table 1. Total precipitation (inches) and temperature (°F) July/August 2006 and 2007.
(Source CLIMOD, Northeast Regional Climate Center)

Location	Precip. (in.)		Temp. (F)	
	<u>2006</u>	<u>2007</u>	<u>2006</u>	<u>2007</u>
Albany	3.4	4.7	72.4	70.6
Buffalo	3.9	2.2	71.7	71
Ithaca	5.8	3.9	71.0	67.7
Islip	5.6	4.7	73.1	73.1
Syracuse	6.7	2.7	71.7	70.3
Watertown	1.4	2.3	69.5	67.7

Insect monitoring:

Soybean aphid (SBA) populations were widely distributed in 2007 and observed at all sentinel site locations. Earliest SBA detections occurred the week of June 15th on vegetative stage seedlings (V2) in Cayuga county. This seasons dry conditions were not conducive to entomopathogenic epidemics that can often help curb development of soybean aphid populations. Early season presence of other natural enemy populations, such as Coccinellid spp, also appeared to be in relatively modest numbers in many locations. These factors likely contributed to the higher than expected soybean aphid populations observed in many areas of NY this season. Although SBA were widely present across the state, SBA populations only exceeded the average of 250 SBA per plant action threshold guidelines in sentinel plots located in 5 counties: Cayuga (7/3, R2), Columbia (7/3, V6), Monroe (8/7, R3), Oneida (7/25, R2) and Onondaga (7/16, V5-7) counties, figure 3. White dwarf SBA populations were reported in Columbia, Chemung, Steuben and Wayne counties, however, did not exceed the action threshold. Bean leaf beetles, a relatively new insect pest in NY, were collected on 8/27 from a soybean field in Cayuga county. Bean leaf beetle was not observed in Ontario county as in 2006. No soybean aphids were observed at the Long Island site.

Soybean pest monitoring insights and outreach linkage:

New York soybean pest information was enhanced by frequent contributions by CCE personnel from soybean producing regions across the state. One particularly helpful group were CCE personnel involved in a Northeast Soybean Promotion Board funded project “Cultivating Enhanced Soybean Management” also known as “Soybean Tactical Agriculture teams” or Soybean TAg. The soybean TAg program was implemented on twenty-five farms in Cayuga, Monroe, Oneida, Ontario and Seneca counties. Four of the 2007 NY sentinel sites were located on farms participating in this TAg program. The soybean TAg program provided an additional opportunity to closely monitor and document soybean pests and crop development. More information on Tactical Agriculture (TAg) teams can be found at: www.nysipm.cornell.edu in the field crops section. The 2007 Soybean TAg report can be found at: <http://www.nysipm.cornell.edu/reports/>. Soybean rust was not detected in any soybean TAg field, however SBA populations were found to be over threshold on twelve of the twenty-nine fields enrolled. Soybean aphid population data for both the sentinel plots and the soybean TAg program are summarized in table 2.

Of the 49 sentinel plot *and* TAg fields for which regular monitoring data is available, two were known to have been treated with the seed treatment insecticide Cruiser max. Neither of these fields reached threshold for SBA. Seventeen fields monitored reached the 250 sba's / plant action guideline, twenty-two fields were known to have been treated for SBA, table 2. Spider mite populations, a problem that can be exacerbated by dry weather conditions, were prevalent in many of the TAg team fields. These data will be helpful in extension outreach to improve grower understanding of soybean pest management decisions and their impacts.

Extension educator involvement and growers discussions in the TAg program complemented the Soybean sentinel effort and provided insights into outreach opportunities. For example, educators identified instances where soybean fields were treated for SBA below the recommended action threshold guideline, in at least one case a field was treated twice. The TAg

effort helped improve grower understanding regarding SBA management and will likely lead to future enhancements to management decisions regarding this pest. Likewise TAg participants received personal training in the identification of diseases, weeds and other insects present in fields.

Table 2. Soybean aphid populations in 2007 Sentinel Plots and Tactical Agriculture programs

County	Sentinel fields* reaching SBA threshold	Sentinel fields* treated for SBA	Tactical Agriculture Program (TAg) Fields enrolled	TAg Fields reaching SBA threshold	TAg Fields treated for SBA
Cayuga	1	1	6	4	4
Chautauqua					
Chemung					
Chenango					
Columbia	1	1			
Cortland					
Jefferson					
Monroe	1	1	5	3	3
Oneida	1	1	8	1	6
Onondaga	1	1			
Ontario			5	3	3
Oswego					
Otsego					
Seneca			5	1	1
St.Lawrence					
Steuben					
Suffolk					
Wayne					
Wyoming					
Total	5	5	29	12	17

* Twenty sentinel plots total, all counties listed had 1 SBR/SBA sentinel plot, except Cayuga county which had 2 sentinel plots.

Summary:

The SBR/SBA sentinel monitoring program did not detect presence of soybean rust in NY this season. Soybean aphid populations were observed in all sentinel plots, with populations exceeding recommended treatment guidelines in five sentinel fields. The network created an excellent opportunity to strengthen communication among CCE personnel, growers and other stakeholders.

USDA is expected to sponsor another SBR/SBA sentinel network program in 2008. Efforts are currently underway to seek funding for continued soybean TAg programs.

This season's soybean rust monitoring information and sentinel plot reports are available on the Cornell plant pathology department website at: www.ppath.cornell.edu/soybeanrustny/. Soybean aphid monitoring observations and other NY information are archived in the NY information section at: www.sbrusa.net/.

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Figure1. Location of NY Soybean Sentinel Survey Sites 2007

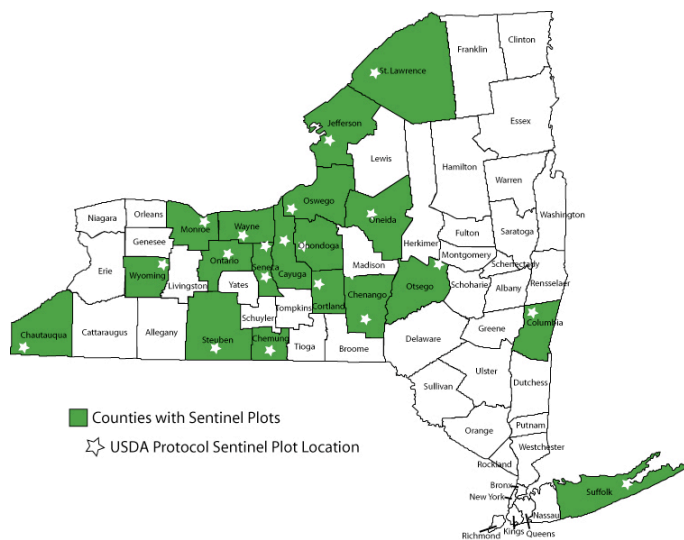


Figure 2. Occurrence of foliar diseases in soybean sentinel plots in 2006 & 2007

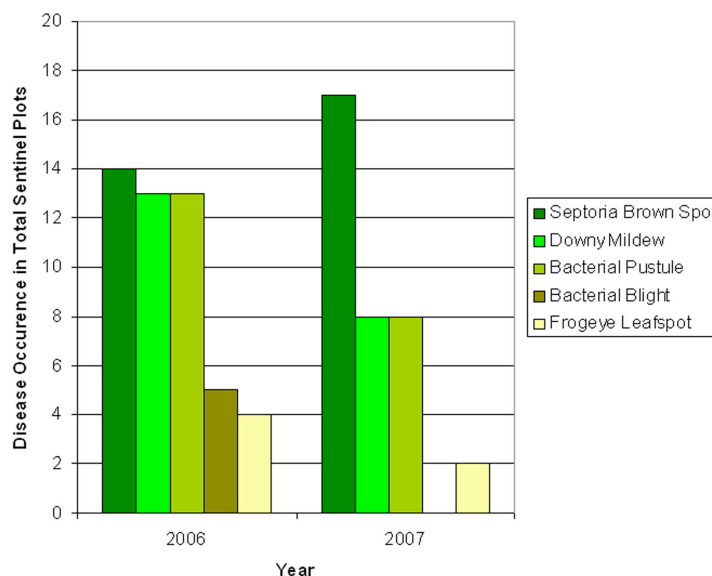
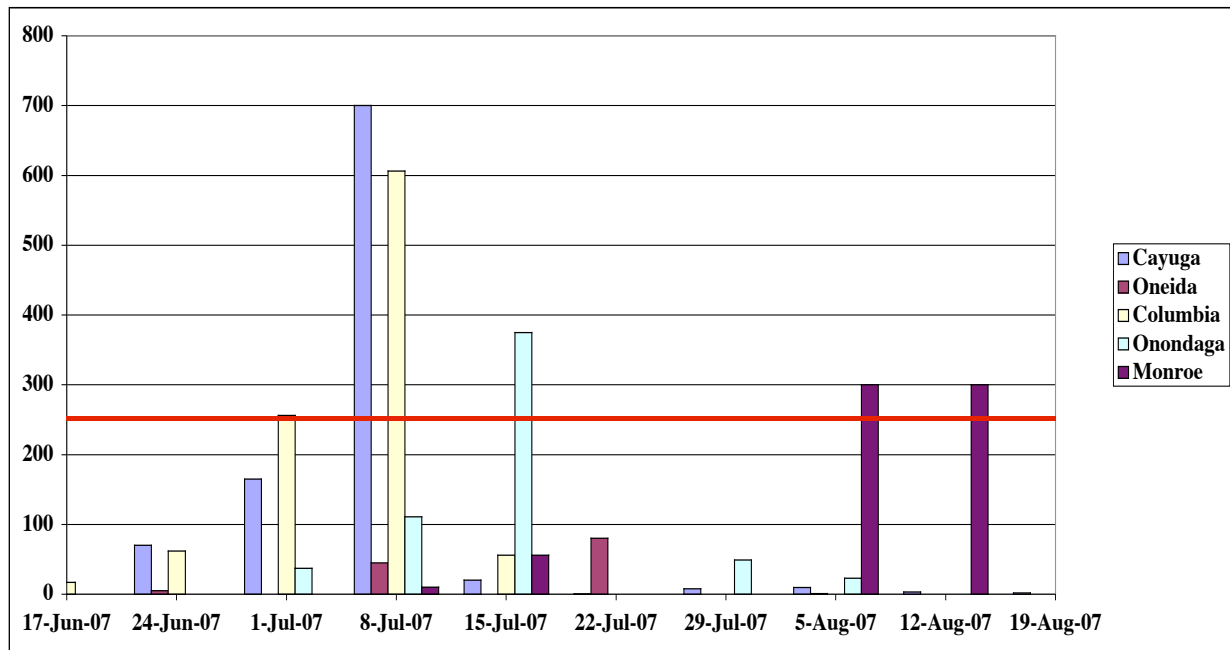


Figure 3. Sentinel plots with over threshold soybean aphid populations, New York 2007.



Appendix 1. Scouting Protocol for Soybean Rust in New York State 2007

(Adapted from the 2007 North American Protocol for Soybean Rust in Sentinel Plots)

1. Sentinel plot size and planting date

- a. Sentinel plots should be at least 50' x 50' for each cultivar/host. Larger plots are encouraged, especially if deer are likely to cause damage to the crop.
- b. Sentinel plots should be planted as early as feasible for the specific geographic region. Sentinel plots in New York are chosen from commercial fields planted on one date. If you're early-planted sentinel plot matures in early September prior to finding rust, switch you're scouting efforts to another soybean field in the area that was planted later or is at an earlier crop stage.

2. Pre-detection SBR monitoring protocol

- a. During the early vegetative stages of growth, scout your plot weekly, make note of any visible problems, and collect and submit only leaves that have visible disease.
- b. Once plants reach the V5 stage, scout weekly for the presence of SBR by arbitrarily collecting or observing a minimum of 100 leaflets from the lower canopy (oldest, main-stem terminal leaflets) at each site. If you happen to see suspicious symptoms outside of the marked sampling area, you may place representative leaves in a separate bag for laboratory inspection as well.
- c. Place your samples in the bag with the collection label that corresponds with your collection number. For example a bag labeled **SBR-01-05**, represents the **fifth** sample taken from **plot 1**.
- d. Complete the label with your name, the collection date and the plant growth stage.
- e. Place the labeled bag inside another Ziploc bag.
- f. Fedex your sample overnight using the Fedex air bills provided. You will need to fill in your return address and the type of packaging you used (i.e. envelope or box).
- g. Only send in your samples on **Monday, Tuesday or Wednesday each week**. The samples must be incubated for at least another 24 hours after they arrive and our summer help does not work on the weekend.

3. Assessment of other diseases on SBR hosts

- a. Samples submitted as part of the NYS soybean rust sentinel network will be assessed for other diseases including: Septoria brown spot, frogeye leaf spot, target spot, downy mildew, bacterial pustule, and bacterial blight.
- b. Weekly reports with results from assessment of other foliar diseases of soybean will be generated for each plot and sent out to scouts. These reports as well as an overall report of the NYS sentinel plot network will also be posted on the New York State Soybean Rust Information Center (<http://www.ppath.cornell.edu/soybeanrustny/default.htm>).

4. Confirmation of SBR positives

- a. Because soybean rust is still considered a regulated disease, the Cornell Plant Disease Diagnostic Clinic will submit the first suspected positive find of SBR in NYS to the USDA lab (Dr. Mary Palm, Beltsville, Maryland) for confirmation.

b. Once soybean rust has been confirmed in New York for the first time, it is not necessary to send additional samples to the USDA lab. At this point, confirmation of rust can be made by the Cornell Plant Disease Diagnostic Clinic. Only the first find in a state or the first find in the U.S. on a different host (a host that has not been documented previously) needs to be sent to the USDA lab.

5. Post-detection SBR monitoring protocols

a. Once SBR has been identified in a sentinel plot or commercial field, it is important to estimate the severity of the disease at larger spatial scales to enable prediction of its spread.

b. Continue to submit samples if **SBR has not been found in your county**.

c. Scout on a weekly basis, inspecting 10 leaflets from each canopy level (lower, mid and upper).

d. Record and submit to Mary McKellar (mem40@cornell.edu) the following information:

- i. disease severity using the 0-100% severity scale (provided or you can download a copy at <http://aphis.zedxinc.com/sbr/SoybeanRust.pdf>)
- ii. incidence (# leaflets infected) for each canopy level
- iii. Growth stage
- iv. Canopy Closure (% of soil covered by the soybean canopy)

Appendix 2. Field Scouting Protocol-Soybean Aphid-2007

Background Information

- Weekly scouting for SBA should begin no later than when soybean plants are in the late vegetative (pre-reproductive) to early reproductive (i.e. flowering) growth stages. Current research data suggests that treatment during vegetative soybean growth stage is not likely to result in an economic return.
- In most cases, weekly scouting will be necessary for no more than 8-10 weeks.
- If a site is treated with foliar or seed-applied insecticide, the site may continue to be monitored as long as the treatment is noted on the observation form.

Soybean Aphid Sampling Procedure

- When scouting for SBA, select 20 plants at random, each from a different location (not consecutive down the row) so that the 20 plant-sample is representative of the entire variety/cultivar. Identify the average plant growth stage.
- Examine the entire plant beginning with the growing point (newest trifoliolate) for soybean aphids.
 - Count aphids when there are 250 or fewer per plant. Estimate numbers when populations are above 250 per plant. Categorize estimates as follows: 250-499; or 500 or above.
 - (FYI: within-field aphid numbers will be mapped on the PIPE site in the following categories: 0) 0; 1) 1-5; 2) 1-39; 3) 40-149; 4) 150-249; 5) 250-499; and 6) 500 and above.
 - Please indicate the number of plants examined when the number is other than 20.
 - In cases where the average was not an estimate but a count, please indicate that on the data entry sheet. You may also indicate incidence (number of plants with aphids) on the data entry sheet.

Other Pest Observations/Optional Notes

- Apterous (wingless) aphids are assumed to be present. Note whether or not alate (winged) aphids were also observed. If only winged aphids are present (very rare, but possible), indicate this information in the space for optional notes. Notes could also be used to mention

- if any predators, parasitized aphids (mummies), diseases, weeds or other pest or crop problems of interest are present or other general relevant observations.
- It is recommended that notes of presence and/or infestation levels of other economically important pests of soybean and other legumes such as common bean also be mentioned by observers. Bean leaf beetle is an important pest of soybean and Mexican bean beetle and leafhoppers are important pests of common bean; and information regarding these pests could be beneficial and utilized by the local state extension specialist in their commentary to growers.

Unusual Aphids/Lab Diagnosis

- Unusual aphids should be submitted to your local National Plant Diagnostic Network (NPDN) lab for specimen preparation and initial screening. Please see the NPDN Soybean Standard Operating Procedure (SOP) for more information. Dr. David Voegtlin, Illinois Natural History Survey, will serve as an expert taxonomic confirmation specialist for soybean aphid or unusual aphids detected through this program. If any unusual or suspect exotic aphids are detected, Dr. Voegtlin will appropriately communicate with 1) the NPDN and 2) Dr. Gary Miller at the USDA Systematic Entomology Laboratory in Beltsville, MD in order to ensure that proper procedures of exotic pest notification are followed.

National Soybean Aphid Management Guidelines - 2007

Last Updated May 01, 2006

(http://www.sbrusa.net/cgi-bin/sbr/public.cgi?pest=soybean_aphid)

Emergence to Vegetative

During the period when the soybean crop is in the emergence to vegetative (not reproductive, i.e. no flowers) growth stages, current research data has shown that spraying will not result in an economic return. Although uncommon, soybean aphids have reached threshold during the vegetative stage in some regions.

R1 to R5 growth stages

- During the period when the soybean crop is reproductive (i.e. flowering) in the R1 to R5 growth stages, an insecticide application may be necessary when 250 or more aphids occur per plant and approximately 80% of the field is infested and populations are increasing. Sequential scouting in the same field is necessary in order to determine if populations are increasing.
- The data scale chosen also potentially corresponds with input of speed scouting information. For more information on the University of Minnesota speed scouting program visit http://www.soybeans.umn.edu/crop/insects/aphid/aphid_sampling.htm . The speed scouting protocol differs from the soybean aphid sentinel plot protocol, but collection of this mobile data is also possible.
- Always read, understand, and follow pesticide label recommendations.
- Please follow your state's insecticide guidelines for more information on pesticide use.
- Insecticide applications should only be considered when needed according to the pest population status.
- Tank mixing with fungicides is not recommended unless soybean aphids have reached threshold requirements mentioned above and spraying for soybean rust treatment is also recommended by your state extension plant pathologist.
- Unnecessary pesticide applications may increase pest problems by adversely affecting beneficial insect natural enemy populations.

R6 growth stage - (full size seed in top 4 nodes)

A higher threshold is required for economic return during the R6 growth stage, but no threshold data is available at this time. If treatment options are considered, ensure pre-harvest intervals of the insecticidal

product chosen are met prior to application.

R7 growth stage - (beginning maturity, one mature pod) **and later**

Soybean Growth and Management Quick Guide

<http://www.ag.ndsu.edu/pubs/plantsci/rowcrops/a1174/a1174w.htm>

Vegetative Stages	Reproductive Stages
VE (emergence)	R1 (beginning bloom, first flower)
VC (cotyledon stage)	R2 (full bloom, flower in top 2 nodes)
V1 (first trifoliolate)	R3 (beginning pod, 3/16" pod in top 4 nodes)
V2 (second trifoliolate)	R4 (full pod, 3/4" pod in top 4 nodes)
V3 (third trifoliolate)	R5 (1/8" seed in top 4 nodes)
V(n) (nth trifoliolate)	R6 (full size seed in top 4 nodes)
V6 (flowering will soon start)	R7 (beginning maturity, one mature pod)
	R8 (full maturity, 95% of pods on the plant are mature)